



**Product
Technology
&
Standardization
Division**

Defense Energy Support Center

Alternative Fuels Information Station

Synthetic Fuels Tutorial





Learning Objectives



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You should learn....

- Important definitions around synthetic fuels
- Why synthetic fuels are needed
- Some detail on the promising methods of producing synthetic fuels
- U.S. demand for petroleum products
- Basic properties of synthetic fuel products



Disclaimer: Although synthetic fuels are not available through the DESC at this time.





DEFINITIONS



SYNTHETIC FUEL DEFINITIONS



WHAT IS SYNTHETIC CRUDE?

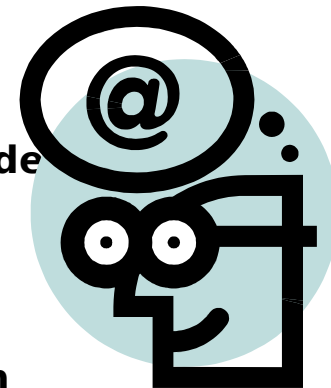


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Definitions of Synthetic Fuel

Synthetic Crude

Any crude oil **NOT** produced from conventional petroleum crude



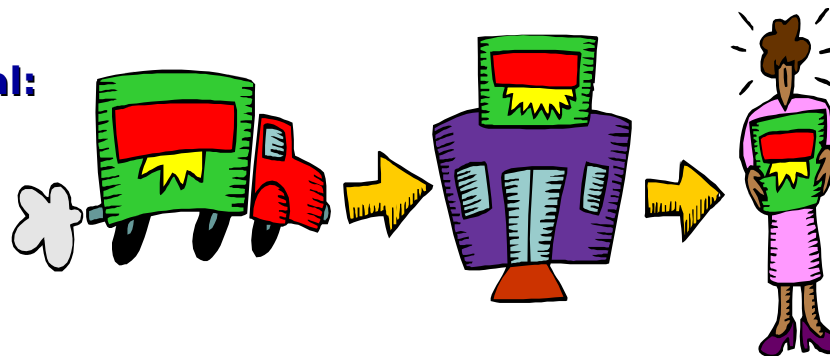
Synthetic Fuels

A generic name given to hydrocarbon fuels produced from natural gas, coal, or biomass.



Resource can be any burnable material:

Coal
Biomass
Natural gas





Why are Synthetic Fuels Needed?



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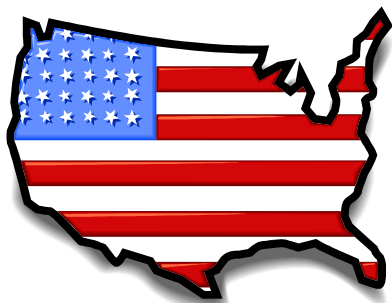
4 Reasons for continued production and improvement of synthetic fuels

World has a finite supply of conventional crude oil

U.S. demand for crude oil is steadily increasing

National Security and energy independence

Synthetic Fuels help reduce U.S. dependency on foreign oil



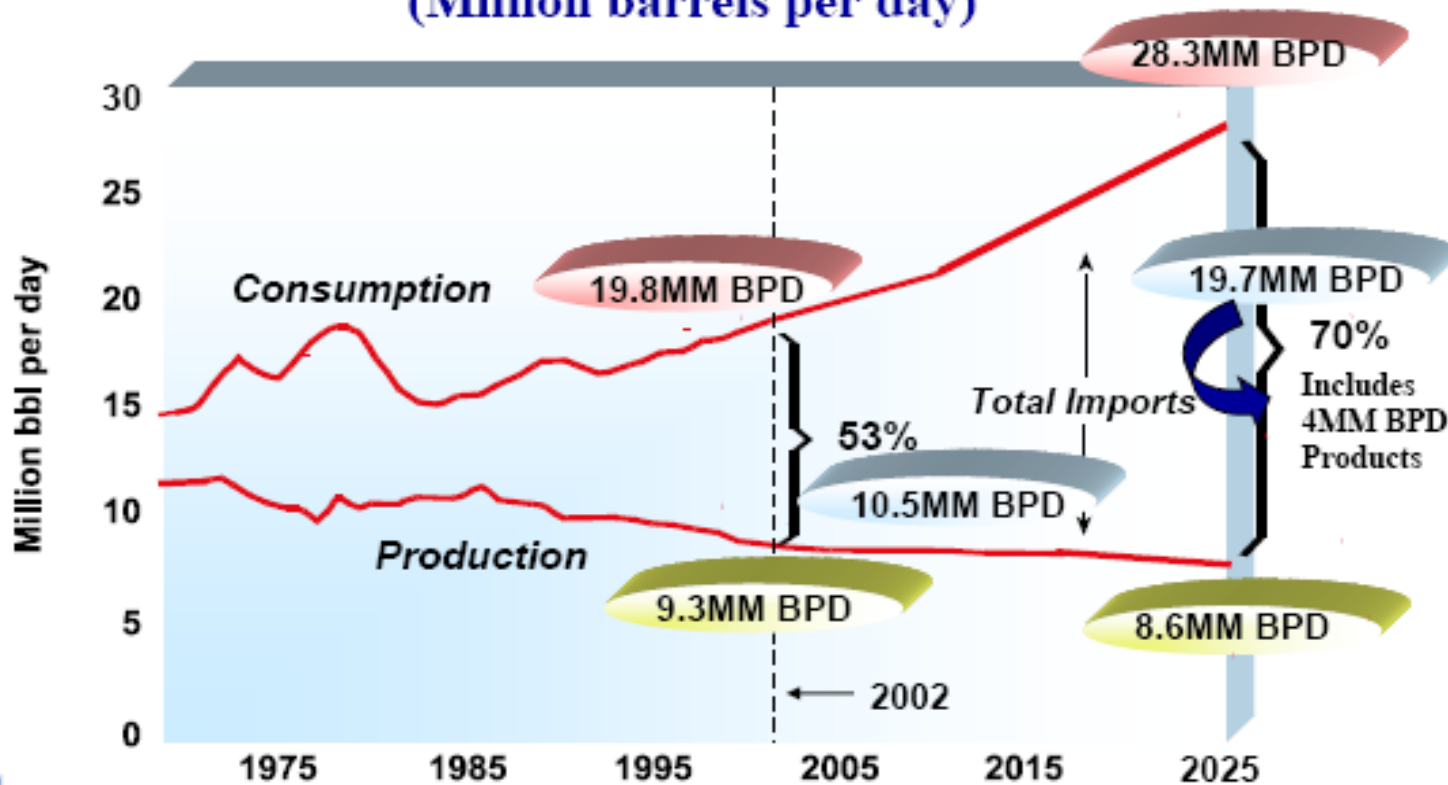


Crude Oil Consumption



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U.S. Production, Consumption, and Total Imports of Petroleum, 1970-2025 (Million barrels per day)



Source: EIA (AEO 2004): Reference Case Scenario





Synthetic Crude Processes



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Synthetic Crude sources include:

1. Natural Gas to Liquids

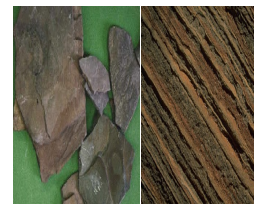


2. Coal Gasification: Producing synthetic natural gas from Coal

3. Coal Liquefaction: Conversion of coal to liquid for use as a synthetic fuel



4. Shale Oil: Extracted hydrocarbon known as Kerogen from shale (large shale formations Exist in Colorado, Utah, and Wyoming)



5. Tar Sands: Extraction of very heavy, asphalt “like” crude oil called Bitumen from grains of sand, or, in some cases, porous carbonate rocks. The U.S. has some tar sands mainly in Utah. The largest deposits are in Canada.





Refining Synthetic Crudes

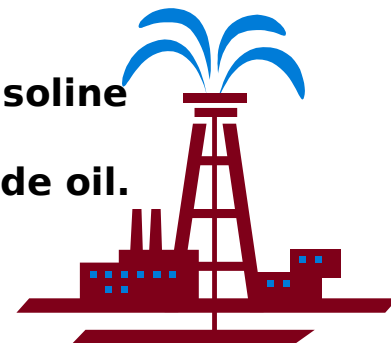


Fisher-Tropsch Process

Fisher-Tropsch (FT) is an emerging technology for Converting synthetic crude to synthetic fuels.

Brief History

- **Developed by Germany during World War II to make gasoline from coal.**
- **Developed out of necessity from a lack of available crude oil.**
- **Modernized in South Africa by SASOL Corporation.**



What is FT?

Converts coal, natural gas, and low-value refinery products into high value, clean burning fuel!

FT offers important emissions benefits compared to conventional fuel.





Conventional Petroleum Crude Oil Processing



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Input

Crude Oil

Primary Separation

Distillation

Distillation

Naptha Cut

C₃ & C₄ Olefins

Distillate Cuts

Conversion

Coking

Cracking

Impurity Removal

Hydrogenation

Hydrogenation

Hydrogenation

Upgrading

Distillation

Distillation

Distillation

Products

Gasoline

Kerosene/Jet Fuels

Diesels/Fuel Oils





Synthetic Crude Oil Processing



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Input

Synthetic Crude

Primary Separation

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Hydrogenation

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Distillation

Distillation

Products

Gasoline

Kerosene/Jet Fuels

Diesels/Fuel Oils





Major Producers of Fisher-Tropsch Fuels



South Africa's Sasol is the largest producer

Other projects include:

BP (Nikiski, AK)

Conoco-Phillips (Ponca City, OK)

Syntrleum (Tulsa, OK)

There are other oil companies developing large scale production Operations using Fisher-Tropsch technology!





SYNTHETIC FUEL



SYNTHETIC FUEL FROM BIOMASS



Synthetic Fuels from Biomass Processing



Synthetic fuels can be created from **"Biomass"**

Biomass can be any plant derived organic matter, available on a renewable basis including:

- Dedicated energy crops and trees
- Agricultural food and feed crops
- Agricultural crop wastes
- Wood wastes and residues
- Aquatic Plants
- Animal wastes
- Municipal wastes and other waste materials





Biomass Resources in the United States



- Abundant, natural and renewable resource
- Supplements fossil energy supply
- Helps create energy security and independence
- Can be used to produce fuels, power, and many chemicals



Source: www.eere.energy.gov/biomass



Biomass Usage



- Leading source of renewable energy in U.S. 1999-2003
- Provides fuel, heat, electricity chemicals and other products
- Agricultural and forestry residues most common resource for generating electricity and process steam
- Increases use of crops for biodiesel and ethanol



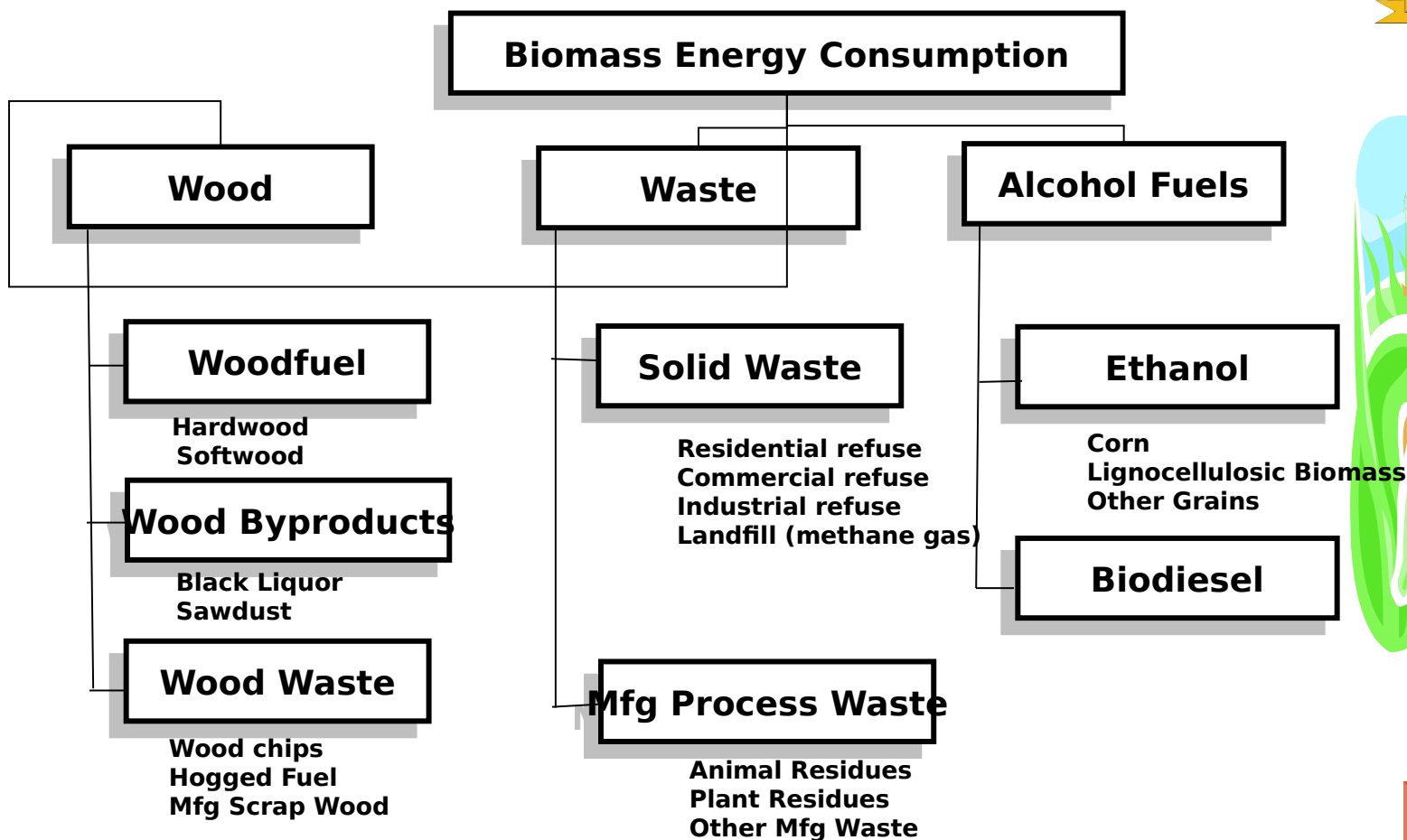
Source: www.eere.energy.gov/biomass



Biomass Resource Hierarchy



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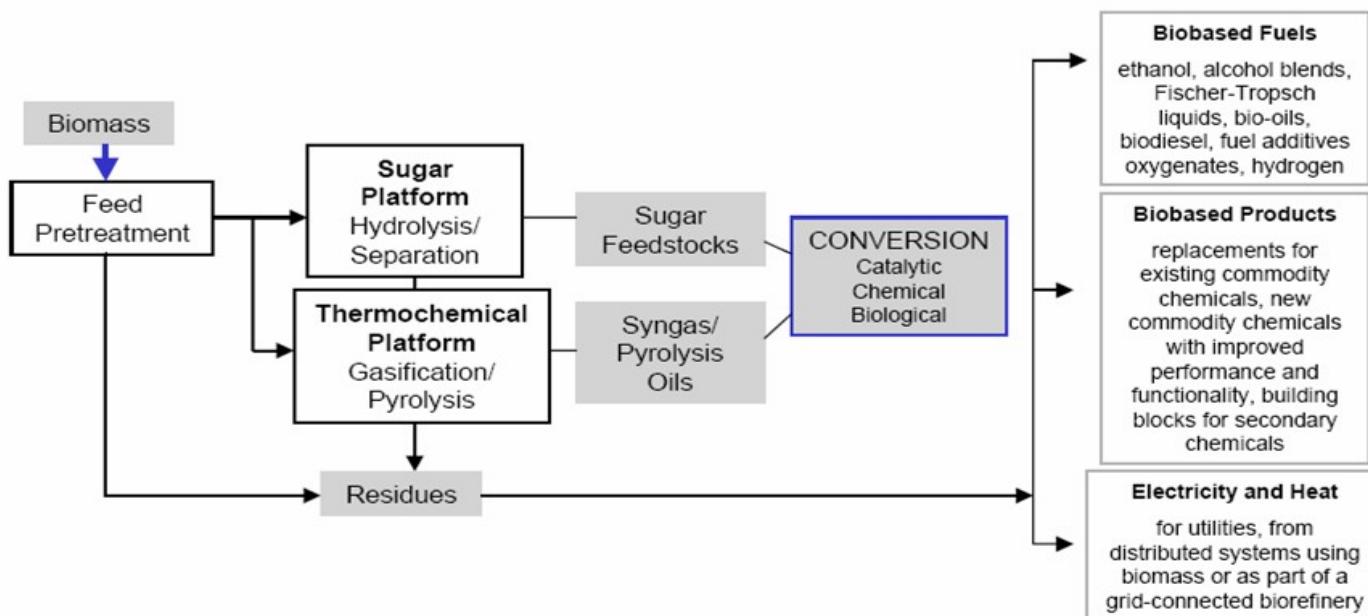




Biomass Platforms



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Biomass Platforms for producing fuels





Synthetic Fuels in the Transportation Sector



SYNTHETIC FUELS IN THE TRANSPORTATION SECTOR

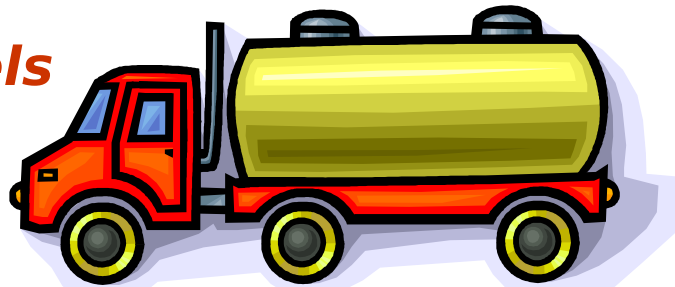


WHAT ARE TRANSPORTATION FUELS?



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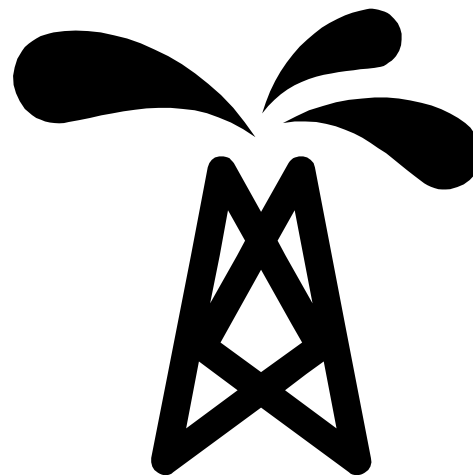
Transportation Fuels



Transportation fuels are refined from conventional petroleum (hydro-carbon based) crude oils.

They include:

- Jet Fuels
- Diesel Fuels
- Gasolines
- Marine Fuels



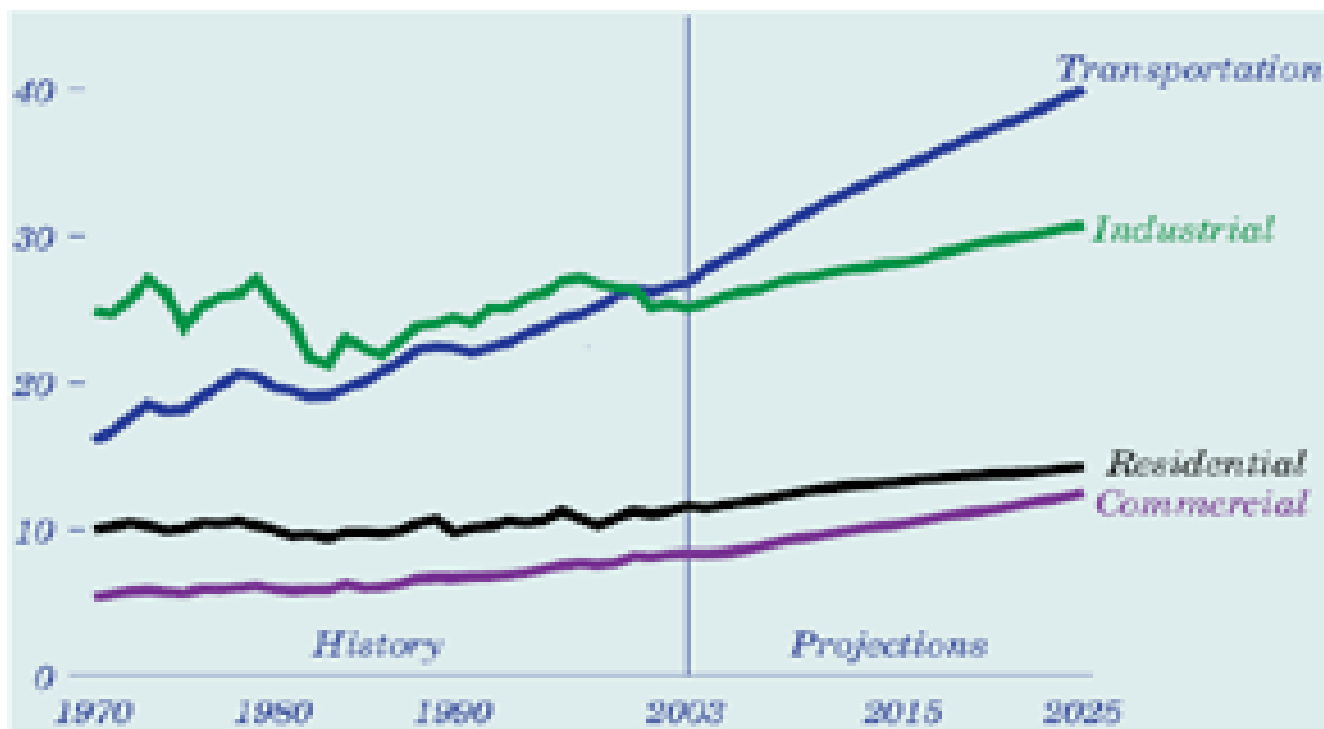


TRANSPORTATION FUEL USAGE



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Delivered Energy Consumption By Sector
(in Quadrillion BTUs)



Note: 1 Quad= 1×10^{15} BTU

Source: www.eia.doe.gov/oiaf/aeo/consumption.html

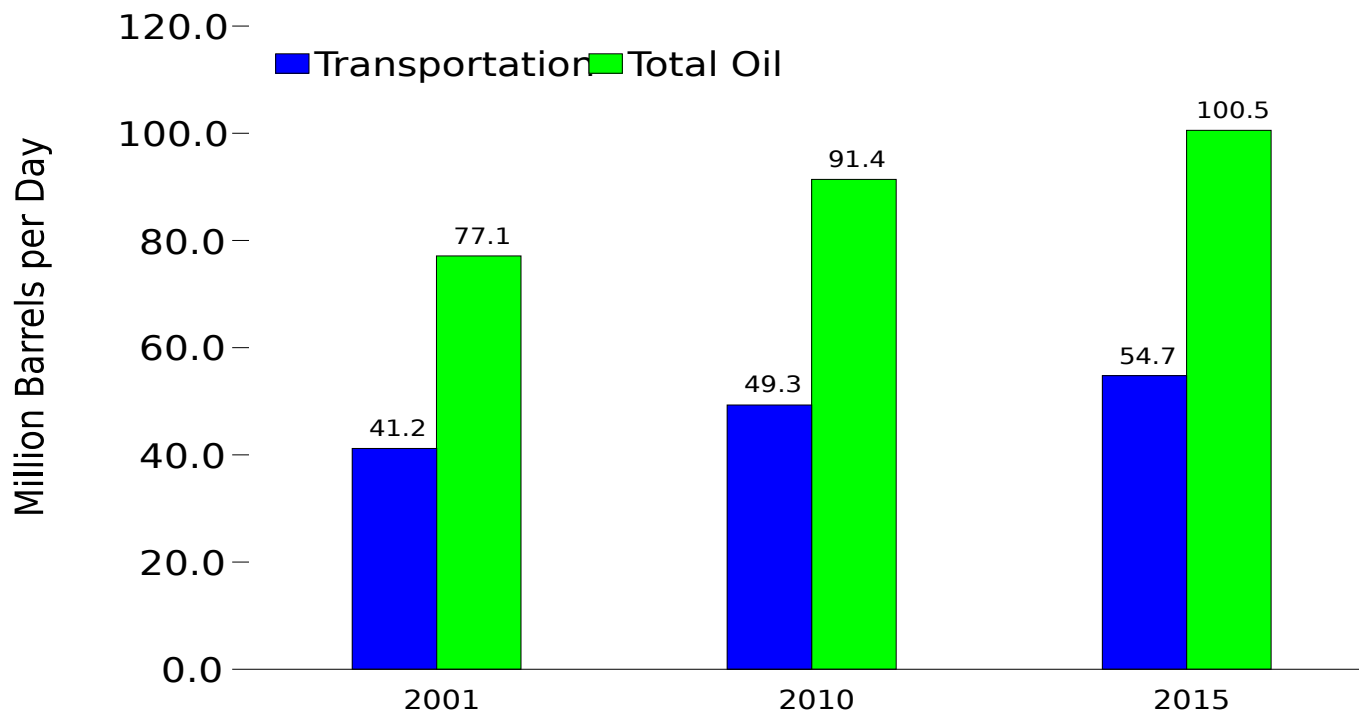




TRANSPORTATION FUEL USAGE



Transportation Fuel Usage vs. Total Fuel Oil Consumption



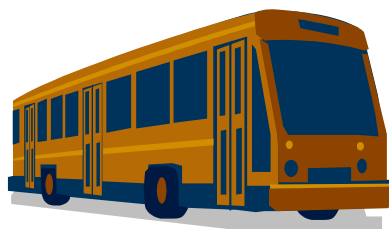


Synthetic Fuel as a Transportation Fuel



Synthetic crude oil can typically be:

- ✓ **Refined using conventional petroleum processes.**
- ✓ **Used with the existing distribution infrastructure**
- ✓ **Used in conventional vehicles (diesel/gasoline/kerosene-jet fuel)**





Transportation Fuel Specifications



TRANSPORTATION FUEL SPECIFICATIONS



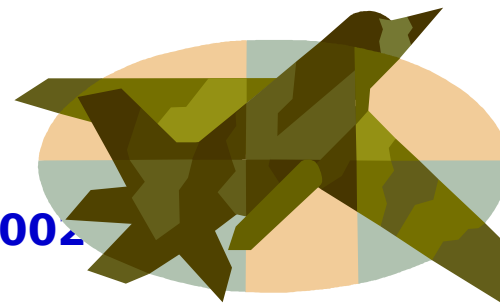
Specification Provisions



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Synthetic Aviation Fuels:

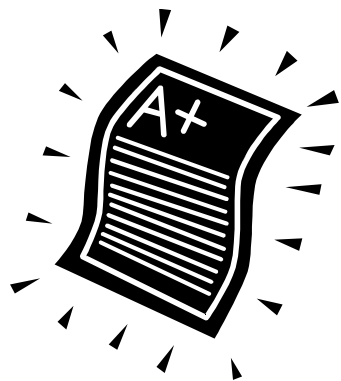
Required to meet Standard Specification for Aviation Fuels- ASTM-D-1655 and Defense Standard 91/91/Issue 4, 14 June 2002



Only SASOL Corporation's semi-synthetic fuel blend of conventional kerosene and synthetic kerosene meets this requirement thus far!



Defense Standard 91/91-Issue 4, stipulates, “ the use of blends represents a departure from experience.....” therefore, “an interim solution ...to approve fuels containing synthetics componen on an individual basis” is actively performed.





Specification Provisions

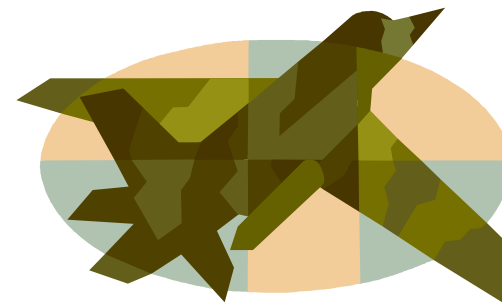


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Synthetic Aviation Fuels (Con't):

JP-8 MIL-DTL-83133E

JP-5 MIL-DTL-5624U



**Allow for certain synthetic crudes:
“crude oil derived from petroleum, tar sands, oil shale or mixtures thereof..”**

Section 3.1 Materials, MIL-DTL-5624U

Synthetic Diesel Fuels:

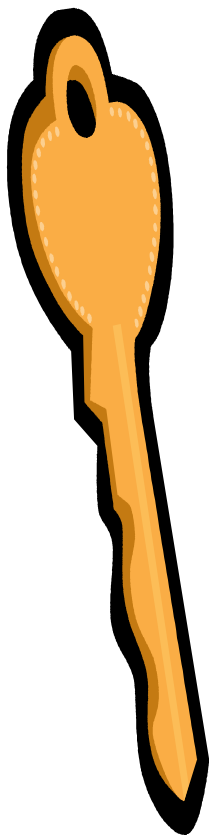
ASTM-D-975

Hydrocarbon source not specified for diesel fuels





Key Advantages of Synthetic Fuels



- ✓ **Can use existing infrastructure**
- ✓ **No sulfur (exceeds EPA 2006 regulations)**
- ✓ **Lower engine exhaust emissions**
- ✓ **Less toxic- no aromatics, bio-degradeable, no hetero-atoms**
- ✓ **Abundant reserves domestically**
- ✓ **Excellent low temperature properties**
- ✓ **Strong long term storage stability**





Present Limitations of Synthetic Fuels



- X **Low lubricity for Diesel Fuels**
- X **Low lubricity for Jet Fuels**
- X **Material compatibility issues in Jet Fuels
(e.g. zero aromatics and the effects on seals)**

All issues are solvable:

- **Additives can be used to remedy lubricity concern.**
- **Material compatibility can be remedied by the use of blends initial**
- **Further development can force progress to full synthetic.**





Summary



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You should now understand....

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- Basic properties of synthetic fuel products

